

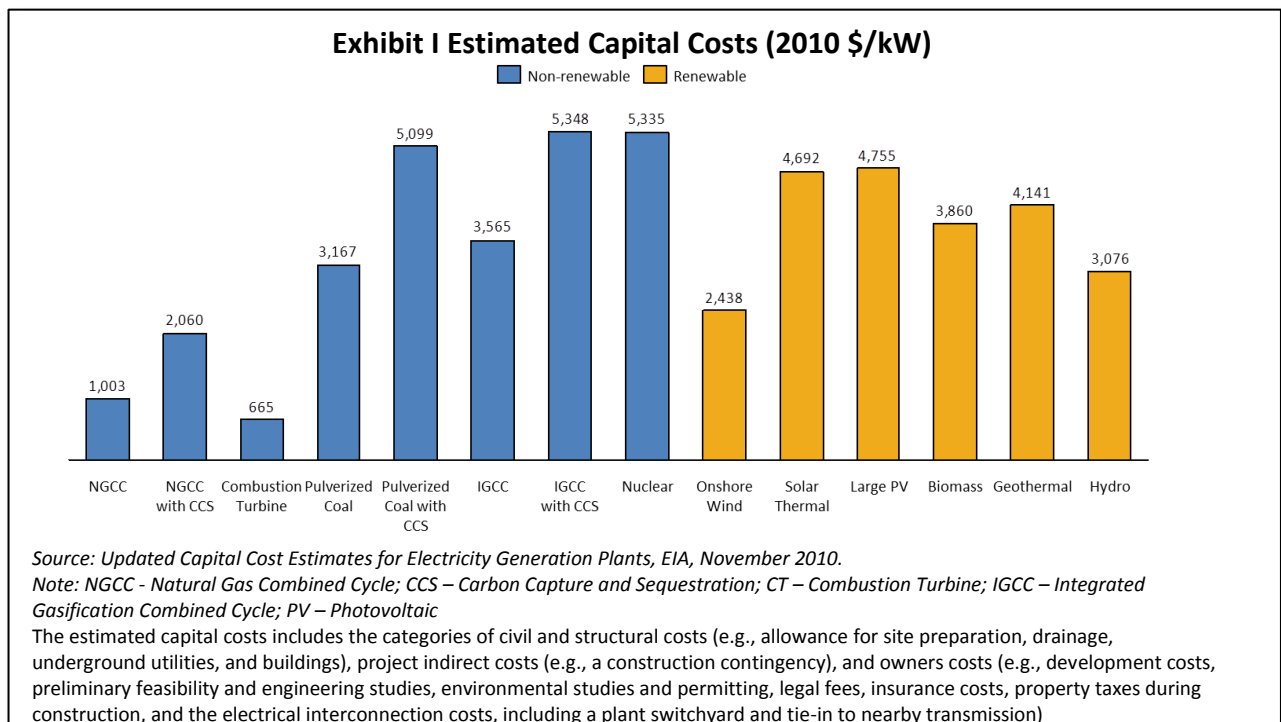
Renewable Energy Question 10: *What are the current and projected relative costs of existing and new builds for wind, solar, hydro, biomass, landfill gas, coal, natural gas, nuclear, and other sources? How would those differ if placed in another jurisdiction electrically tied to Michigan?*

## Executive Summary

1. Wind generation has higher capital costs than natural gas-fired generation and lower capital costs than coal and nuclear generation
2. The capital cost only represents one aspect of the comparison among different generating technologies. Additional aspects to consider include: (1) different fuel costs and other cost drivers; (2) different capacity factors; (3) other types of capital costs that are necessary to interconnect certain technologies into the electric grid
3. Capital costs of both renewable and conventional generation technologies in Michigan are lower than the averages in states that are electrically tied to Michigan. Moreover, additional transmission costs could be incurred to transport electricity from out-of-state generation sources to in-state customers

### 1. Wind generation has higher capital costs than natural gas-fired generation and lower capital costs than coal and nuclear generation

The Energy Information Administration (EIA) provided detailed capital cost estimates for utility-scale electric generating plants in the November 2010 report on *Updated Capital Cost Estimates for Electricity Generation Plants*.



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As seen in Exhibit I, wind generation has higher capital costs than combined cycle and combustion turbine natural gas plants on a per kilowatt basis and lower costs than other conventional technologies such as coal and nuclear.

The capital costs of different technologies shown in Exhibit I represent the costs of typical generation plants that would be built today. They also reflect a national average view. Regional differences exist and are addressed in section 3.

**2. The capital cost only represents one aspect of the comparison among different generating technologies. Additional aspects to consider include (1) different fuel costs and other cost drivers, (2) different capacity factors, and (3) other types of capital costs that are necessary to interconnect certain technologies into the electric grid**

It is important to understand that capital cost only reflects one aspect of the comparison among different generating technologies. Additional aspects that are important to consider include:

Different fuel costs and other cost drivers: different generation technologies use different types of fuel including natural gas, coal, uranium, wind, sunlight, biomass, geothermal, and water. Some fuels are more expensive than others and some fuels have no cost. In addition to fuel costs, the generating technologies can have very different operating and maintenance (O&M) costs profiles. According to EIA, the fixed O&M costs vary from \$7/kW-year for an advanced combustion turbine (CT) plant to \$100/kW-year for a biomass plant.

Different capacity factors: capacity factors not only depend on technology types but also the load shape and the existing resource mix in the area where additional capacity is installed. Renewable generation plants such as wind and solar have a natural constraint on their capacity factors based on availability of the fuel sources. For example, Michigan's solar resource has some of the lowest potential in the nation and therefore solar plants in Michigan also have the lowest capacity factor. When a generation plant has a lower capacity factor, the cost of each unit of electricity it produces tends to be higher. Capacity factors of conventional technologies such as coal, natural gas combined cycle and combustion turbine depend on their variable costs in comparison with existing generation resources. Nonetheless, capacity factors of conventional technologies are generally higher than those of most renewable technologies.

Other types of capital costs that are necessary to interconnect certain technologies into the electric grid: one of the additional capital costs that will make a meaningful difference among generating technologies is the transmission upgrade cost to connect and transport power from

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the new generating plants to load centers. Transmission upgrade costs can vary based on location, size, type, and operating characteristics of the generating plants.

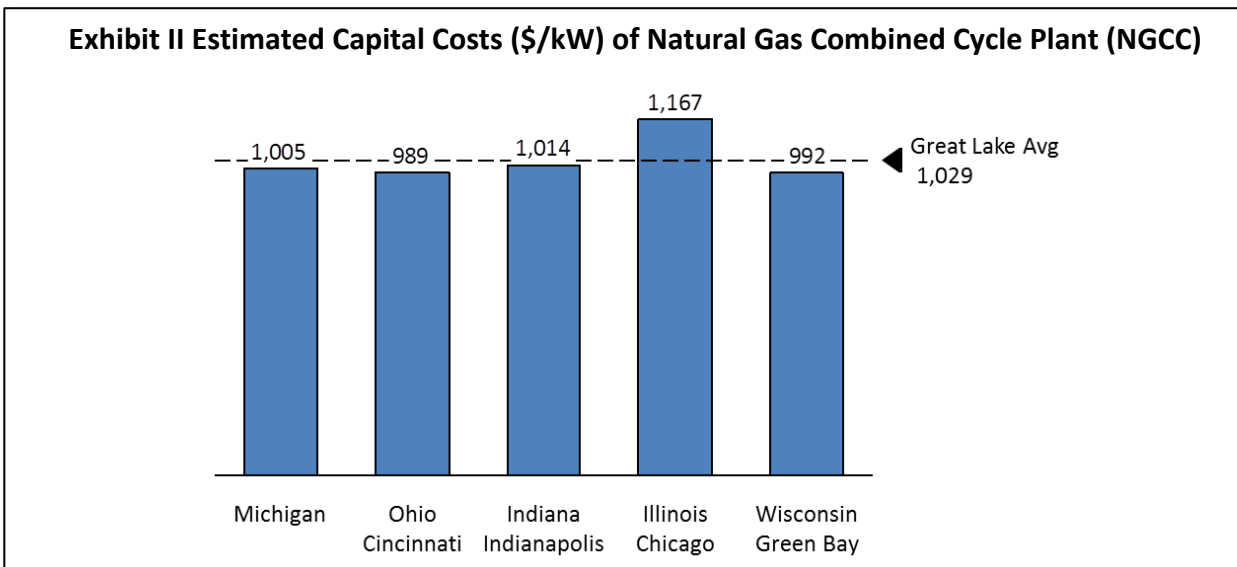
**3. Capital costs of both renewable and conventional generation technologies in Michigan are lower than the averages in states that are electrically tied to Michigan. Moreover, additional transmission costs could be incurred to transport electricity from out-of-state generation sources to in-state customers**

The EIA report referenced above also estimated the capital costs of the same generating technologies in different U.S. locations. The location-based cost estimates took into consideration the installation difference, design difference, labor wages and productivity difference, owner cost difference, remote location issues, location adjustments, difference in overheads and other technology or area specific differences.

Michigan has direct electrical ties to other Great Lakes states: Ohio, Indiana, Illinois and Wisconsin. Exhibits II - VI summarize the capital cost difference among the five Great Lakes states on the most common technologies.

The cost comparison of different technologies indicates Michigan's capital costs<sup>1</sup> are lower than the averages compared to the other Great Lakes states that are electrically tied to Michigan.

More importantly, if new generation plants are placed outside of Michigan and used to supply electricity to Michigan customers, additional transmission costs could be incurred in order to transport the electricity to in-state customers.

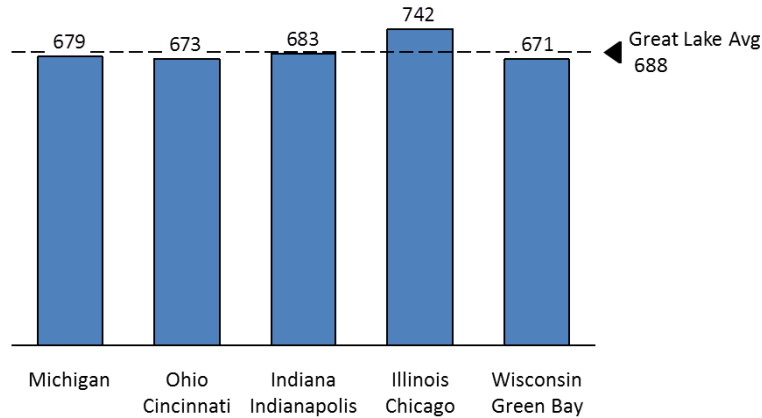


<sup>1</sup> EIA listed two cost estimates for Michigan: one is for new projects around Detroit; the other is for new projects around Grand Rapids. Michigan costs presented in Exhibit II-VI are the average of the two cost estimates.

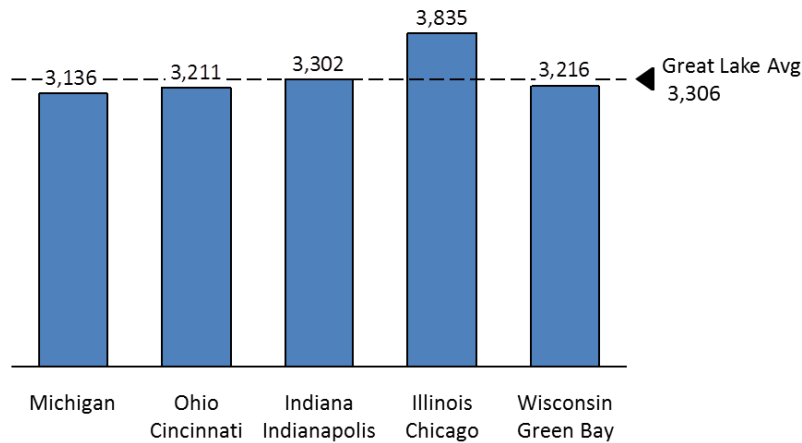
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**Exhibit III Estimated Capital Costs (\$/kW) of Natural Gas Combustion Turbine Plant (CT)**



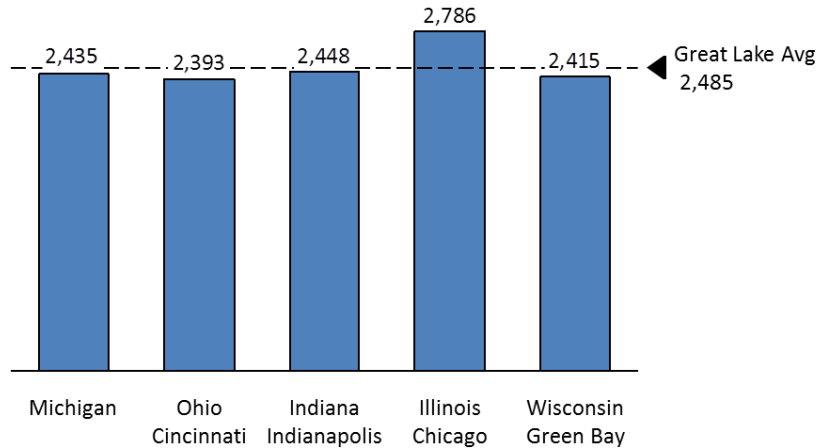
**Exhibit IV Estimated Capital Costs (\$/kW) of Pulverized Coal Plant**



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**Exhibit V Estimated Capital Costs (\$/kW) of Onshore Wind Plant**



**Exhibit VI Estimated Capital Costs (\$/kW) of Utility-Scaled Solar Photovoltaic (PV)**

